

THE USAID/DOE MEXICO RENEWABLE ENERGY PROGRAM: BUILDING FOUNDATIONS FOR GROWING MARKETS

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ABSTRACT

The Mexico Renewable Energy Program, managed by Sandia National Laboratories, is developing sustainable markets through the implementation of pilot projects. Sandia provides technical assistance to Mexican rural development and conservation organizations to improve their capability to utilize renewables within their ongoing programs. In the area of water pumping, alone, the tremendous rural demand for water represents a potential renewable market of over \$500 million. Through the program, more than 120 photovoltaic water pumping projects have been installed in 8 Mexican states, most in partnership with the Mexican Trust for Shared Risk (FIRCO). More than 50 additional projects have been implemented for other applications, including electrification and remote communications. Evidence of project replication is amassing as more people learn about the benefits of program-installed systems and FIRCO moves to implement projects nationwide. More than 45 Mexican and U.S. companies have participated in the program to date, and several long-term partnerships have developed as a result. The program is sponsored by the U.S. Department of Energy and the U.S. Agency for International Development.

1. BACKGROUND

Tremendous opportunities exist in Mexico for growth in the use of renewable energy technologies. Over 5 million Mexicans do not have access to grid electricity in 88,000 villages, while more than 100,000 rural communities are in need of potable drinking water. There are over 600,000 rural ranches in need of water for livestock and/or

irrigation. Given Mexico's abundant solar and wind resources, these rural needs represent a potential market for renewable energy technologies of over \$1 billion. In addition, the excellent wind resources in southern Mexico have led the national utility to consider the development of over 2,000 MW of grid-tied wind energy potential in the Tehuantepec Isthmus alone.

Mexico's proximity to the U.S. makes it an especially attractive potential market for the U.S. renewables industry. The North American Free Trade Agreement facilitates the import of U.S.-produced renewable energy products into Mexico by effectively removing applicable tariffs. This proximity also facilitates the establishment of business relationships between U.S. and Mexican renewable equipment suppliers.

2. PROGRAM OVERVIEW

Sandia began collaborating with Mexico institutions involved in the development of renewable energy projects in 1992, through a cooperative technical assistance program called PROCER. In 1994, the U.S. Department of Energy (USDOE) and the U.S. Agency for International Development (USAID) initiated the Mexico Renewable Energy Development Program, managed by Sandia National Laboratories. The primary goals of the Mexico program are to increase the appropriate use of renewable energy technologies through the creation of sustainable markets for renewables, thereby demonstrating their use in combating global climate change through offsetting greenhouse gas emissions.

Sandia has developed a multi-organizational international team for program development. The National Renewable Energy Laboratory (NREL) is a program partner for all resource assessment and wind-related activities, including project identification and implementation. The program team is also comprised of the Southwest Technology Development Institute (SWTDI) at New Mexico State University, Ecoturismo y Nuevas Tecnologías, Enersol Associates, and Winrock International. Development Associates, Inc., a USAID-funded organization, has partnered with the program for sponsorship of Mexico training activities.

2.1 Focus on Sustainable Markets

In working to establish sustainable markets for renewable energy, the Mexico program does not seek to set up new organizations, programs, or projects centered around renewable energy per se. Instead, the program focuses on selected end-uses of energy, such as agricultural water pumping or remote communications, and incorporates the appropriate use of renewable energy into associated ongoing and funded development programs. Sandia's Systems Assistance Center has used this approach with considerable success for many years in U.S.-focused programs, such as with the National Park Service. Instead of having to build local capacity from ground-zero, the program augments existing local capacity for project implementation with the necessary training in how to successfully assess, select, purchase, and use renewable energy technologies. By working through existing development activities, this approach facilitates access to rural end users and reduces the time required to identify and implement viable, locally-championed renewable energy-based projects.

Project implementation activities under the program to date have focused on off-grid rural "productive use" applications, where the use of renewable energy technologies provides a measurable economic and/or social benefit to the end users. These applications are highly sustainable and replicable, because they provide a mechanism for paying for the renewable energy systems. Examples of productive use include water pumping for livestock or crop irrigation, lighting for commercial or business activities, milking machines, and ecotourism.

2.2 Projects Implemented Through In-Country Partnerships

Program development activities have been conducted in partnership with Mexican organizations at both the state, federal, and non-government levels, as well as with U.S. and Mexican industries. The most significant in-country partnership has been with the Federal Trust for Shared Risk (FIRCO - Fideicomiso de Riesgo Compartido),

which is an agricultural development organization under the Secretariat of Agriculture, and has offices in each of the 32 Mexican states. SNL has established contracts with FIRCO in the states of Sonora, Baja California Sur, San Luis Potosí, Oaxaca, and Quintana Roo for livestock watering projects. In Chihuahua, where program activities were initiated, Sandia and SWTDI cooperate with the Chihuahua Renewable Energy Working Group, which formed as part of this program and is coordinated by the State Directorate of Rural Development (DGDR - Dirección General de Desarrollo Rural). This group is comprised of 12 governmental, university, and non-government organizations (NGOs), including FIRCO. The Chihuahua program was showcased at the Mexican National Solar Energy Association (ANES) meeting in October 1997 and has gained national recognition as a model for renewables project implementation.

Sandia has also signed contracts with three international conservation organizations (The Nature Conservancy, Conservation International, and the World Wildlife Fund) to facilitate the use of renewables in the management of protected areas and as tools in the sustainable development of "buffer communities"—those that border ecologically sensitive regions. Sandia is working directly with these organizations and their in-country partners to implement highly visible renewable energy projects.

Partnerships with members of the Mexican and U.S. renewable energy and utilities industries are designed to improve local system quality and reduce barriers to commercialization in under-developed markets and for new products. Data collected from installed systems also assist the renewables industry in the development of new technologies and in the improvement of existing technologies.

The program is also expanding collaborations with other Mexican organizations involved in the development and application of renewable energy technologies, such as the Center for Energy Studies at the Autonomous University of Mexico (UNAM - Universidad Nacional Autónoma de México), the Mexican National Solar Energy Association (ANES - Asociación Nacional de Energía Solar), the National Energy Conservation Commission (CONAE - Comisión Nacional Para el Ahorro de Energía), and the National Electricity Commission (Comisión Federal de Electricidad).

Working with these partner organizations, the Sandia team conducts a wide range of technical assistance activities to help these partners effectively incorporate renewables into their programs. A variety of training activities serves as the cornerstone to this technical assistance. Workshops focus on environmental and economic benefits of renewables; technical issues related to design and

installation practices; development of long-term maintenance plans for suppliers and end-users; and raising awareness of the importance system acceptance testing and installation guarantees. Project analysis activities involve technical and economic feasibility, environmental impact, and follow-up monitoring and evaluation. Resource assessment activities are conducted to quantify the solar and wind resources throughout Mexico to facilitate appropriate project development. Ongoing technical assistance is provided to reinforce these factors critical to building long-term markets.

3. PROGRAM RESULTS

Since the inception of the renewable energy program in 1994, more than 170 renewable energy systems, representing more than 100 kWp, have been installed to provide energy for more than 9000 rural Mexicans in 8 states. Approximately 120 of these installations are water pumping applications and more than 50 are for electrification, communications, and other applications. Figure 1 shows the overall renewable capacity that has been installed since the inception of the program. While the majority of these projects have utilized photovoltaic energy, the program is demonstrating wind energy in several applications including water pumping, facilities power for hotels and visitor centers at reserves, and centralized community hybrid systems. Project costs have been covered by contributions from Sandia, the local counterpart agencies, and end users, with the Sandia contributions averaging less than 50% of the project costs.

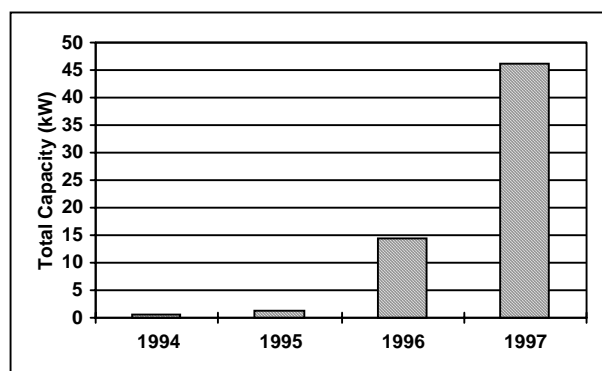


Figure 1. Mexico Program Installed Renewable Energy Capacity per Year.

All systems have been implemented in conjunction with local partners who have received training through the program. To date, the program has trained over 1,500 state and federal decision makers, engineers, technicians, conservation and development specialists, and vendors, from more than 90 organizations in fourteen Mexican states in the appropriate use of renewable energy technologies.

As a result of program activities, more suppliers are providing better systems at generally lower prices than before this program was initiated. In Chihuahua, for example, where program activities were initiated in 1994, the number of highly competent renewable energy equipment suppliers has grown from 4 to 10. In total, more than 25 local system suppliers throughout Mexico have participated in the program. These industry growth trends and increasing competition have helped to lower overall installed system costs, while quality levels have improved substantially. For instance, installed costs of PV water pumping systems have decreased as vendors and program administrators gain experience with technologies; this despite the fact that PV module prices have not fallen over the same time frame. Figure 2 illustrates this trend, showing the decrease in costs for water pumping systems purchased program-wide. Figure 2 also shows examples for the states of Chihuahua and Baja California Sur, where the program has had very positive results over the last 2 to 4 years. Note that these costs include all system hardware (pumps, conductors, etc.), as well as labor and taxes. Many of these same vendors also have expanded their service territories to other states, further contributing to increased competition and decreasing system costs nationwide.

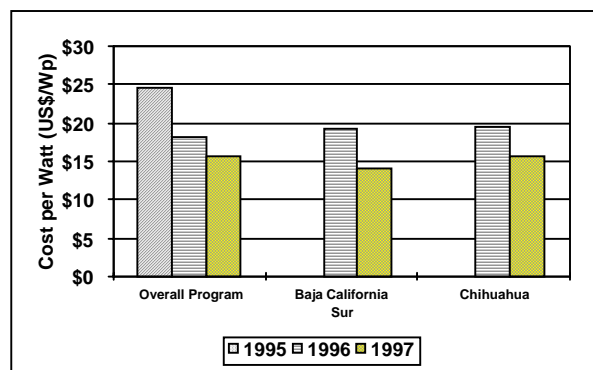


Figure 2. Mexico Program PV Water Pumping Systems Average Cost per Watt.

The Sandia team maintains a continually updated database on technical, economic, social, and environmental aspects of the installed renewable systems. Using the information in this database, project developers can determine the appropriateness of renewable energy technologies to meet their future needs, and industry members can assess the performance of their fielded systems, thus providing valuable feedback for technology improvements. Sandia can also assess the effectiveness of program activities by analyzing the information in the database. For instance, all available information regarding maintenance actions with installed systems is maintained in the database. Table 1 shows summary maintenance information in the

database as of October, 1997. An extensive update to this information is planned for mid-year in 1998.

Table 1. Mexico Program
Maintenance Actions as of October, 1997

Type of Maintenance	No. of Occurrences
Emergency	1
Planned maintenance	8
Unplanned maintenance	7
No maintenance activity	56

As part of the assessment of program results, the Sandia team is utilizing information maintained in the database to determine the economic benefits of the types of systems installed through the program. Figure 3 is an example of the output of an economic analysis of a typical water pumping system installed in Chihuahua. In this case, the photovoltaic system replaced a diesel generator, so real data were available regarding the comparative costs of using diesel versus photovoltaics. As can be seen in Figure 3, in spite of higher initial costs, after 2.5 years, the PV system actually represents a lower overall cost to the end user.

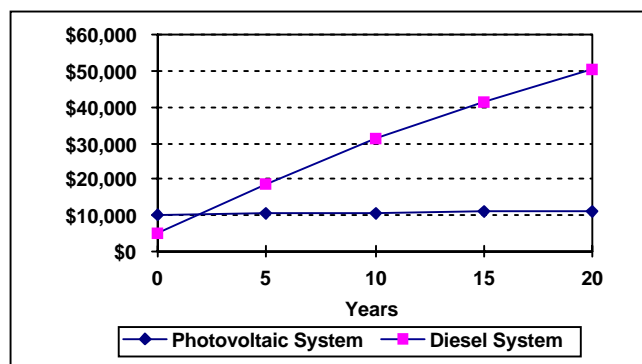


Figure 3. Comparison of Costs of Existing PV Water Pumping System vs. The Diesel Pump that It Replaced in Jeromin, Chihuahua.

Partnerships with industry and international industry collaborations continue to grow through involvement with the program. More than 45 U.S. and Mexican companies have participated in the program, with several international partnerships having been formed as a result. Working with SunWize Technologies, Inc., Sandia, SWTDI, the State of Chihuahua, and the New York State Research and Development Authority are collaborating on the development and implementation of a pilot hybrid (PV/diesel) ice-making system in Chihuahua, to be installed in the summer of 1998. A prototype system has already been installed and monitored at SWTDI over the past year. In an example of a utility partnership, Sandia is providing technical and financial support to CFE and Arizona Public Service in the development and

implementation of a centralized wind/solar/diesel hybrid community power system in the state of Baja California Sur. This system is also scheduled for installation in 1998. Through these and other partnerships, U.S. suppliers gain access to growing new markets, while Mexican suppliers receive technical support and a supply of equipment.

4. EVIDENCE OF REPLICATION AMASSING

The best evidence of growing, sustainable markets for renewable energy technologies in Mexico comes from replication of projects through non-program funding, such as other Mexican development programs, private or public financing, or simply through private purchases. Working with FIRCO, the Sandia Mexico program has successfully negotiated the inclusion of renewable energy technologies as a line item in the \$1.8 billion six-year rural development program called Alliance for the Countryside (Alianza Para el Campo). Under this program, participating ranchers and farmers can receive up to 50% reimbursement of the costs associated with modernizing their operations. Sandia and FIRCO engineers are collaborating to provide technical assistance to interested end users. More than 50 pilot PV water pumping projects under the Alianza program have been installed in Mexico thus far, and several hundred more have been identified.

Several other examples of project replication indicate growing markets based on the activities of the Sandia program. In general, suppliers of photovoltaic pumping systems in Mexico indicate that each installation done in conjunction with the Sandia program leads to several other sales. For example, one company in the state of Sonora has reported that in 1997, they installed 31 water pumping systems for private ranchers, only 4 of which were in association with the Sandia program. The vendor directly attributes the opening of this market in Sonora to Sandia program activities.

Replication of projects in the protected areas component of the program indicate a significant advance for the industry in Southern Mexico, where the varying quality of past installations left many people with negative perceptions of photovoltaics. Collaboration on several projects with conservation partners led to improved installations and service by local suppliers for training centers, ranger stations, and surrounding communities. These highly visible projects inspired the residents of five communities to access municipal funding to support the installation of more than 10kW of photovoltaic lighting systems for their homes. Meanwhile, through technical assistance to NGOs, end-user confidence and ability to properly operate and maintain their systems over the long run is significantly enhanced. Additional requests have

been submitted to Sandia for technical assistance in procuring lighting systems in as many as 50 other communities.

5. LESSONS LEARNED

Over the last five years, the Mexico Renewable Energy Program has had the good fortune to withstand budget cycles, changing leadership in both Mexico and the U.S., and other potential pitfalls, to remain in existence long enough to produce impressive results. In the process, many lessons have been learned—some easy, some hard—regarding the development of a strategy and the implementation of such a program. Listed below are some of the more important lessons learned.

- As with all development-related activities, a grass-roots approach is essential. This is especially important in Mexico, where government activities are becoming more decentralized and more decisions are made locally. At the local level, a critical mass of different agencies provides a strong base for dissemination and replication.
- Strategic planning in collaboration with partners is necessary to create realistic goals for the integration of renewables into their established programs. In addition, the complementary expertise of partner organizations must be utilized effectively to access rural markets for renewable energy. Planning should include sufficient promotional and training activities to accelerate acceptance of the technologies.
- Program success depends heavily on the adequate provision of training and technical assistance to local suppliers of renewable energy systems. Greater technical capacity of suppliers leads to greater consumer confidence and less work on the part of the consumer and partner organizations in terms of assuring quality projects. In the Mexico program, suppliers are required to guarantee the operation of installed systems and offer terms for follow-on maintenance. Program partners are also instructed to perform technical acceptance tests of all installed systems. Suppliers therefore must be able to meet these requirements and still maintain their profit margins. They are generally very eager to receive training.
- In order to produce a significant market impact, the up-front costs of renewables must be affordable to rural people, either through cost-sharing or financing. Program investments in helping to offset these initial costs greatly facilitate renewable technology visibility, acceptance, and replication. As local

competition develops, these initial costs will decrease. In the absence of these initial cost shares, some other form of financing is needed to facilitate early acceptance of the technologies.

6. CONCLUSIONS

Through increasing the visibility of renewable energy technologies in Mexico and demonstrating the benefits to rural users, the program is producing results that provide evidence of sustainable, growing markets in several regions of the country. In addition to utilizing renewables as an integral part of their development activities, partner organizations now have the technical capacity to require high quality installations from suppliers. Working with the Sandia technical team, local suppliers have also learned to improve the quality of their installations and to provide follow-on maintenance of installed renewable energy projects. The increased visibility brought on by program installations has led to stronger competition, lower prices, higher quality, and significant growth in the number of new systems installed.

Although the implementation of pilot projects continues, the Sandia team is now focusing its efforts on the replication of existing projects and the increased transfer of program management activities to Mexican organizations. Pilot end-user financing programs are planned in Chihuahua and Baja California Sur, with others to follow. Appropriate organizations such as FIRCO, UNAM, and possibly CONAE will develop greater roles in the training and provision of technical assistance as program activities spread to a national level. These activities are viewed as fundamental to the continued growth of sustainable markets for renewable energy technologies throughout Mexico.